Hybrid System Analysis of Dangerous Effects of Alerting Dissonance

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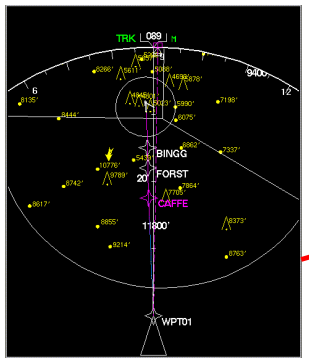
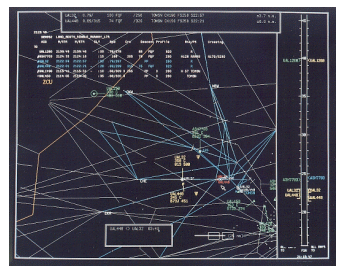
Multiple Decision Support Systems in ATM

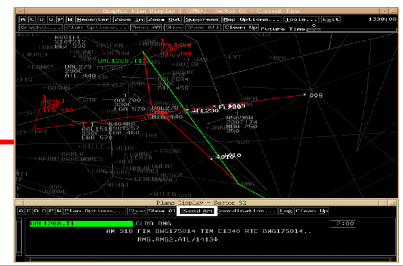
TCAS



GPWS

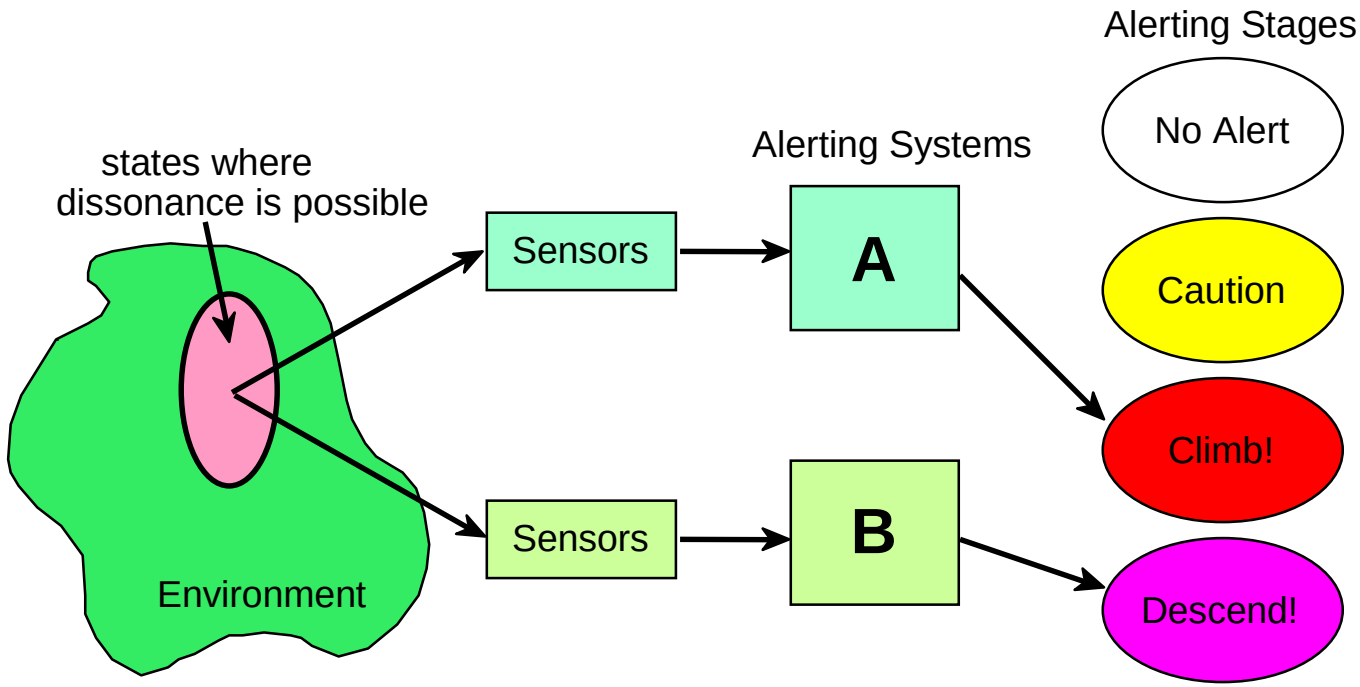


CTAS
Descent Advisor



URET
Conflict resolution

Multiple Alerting System Dissonance

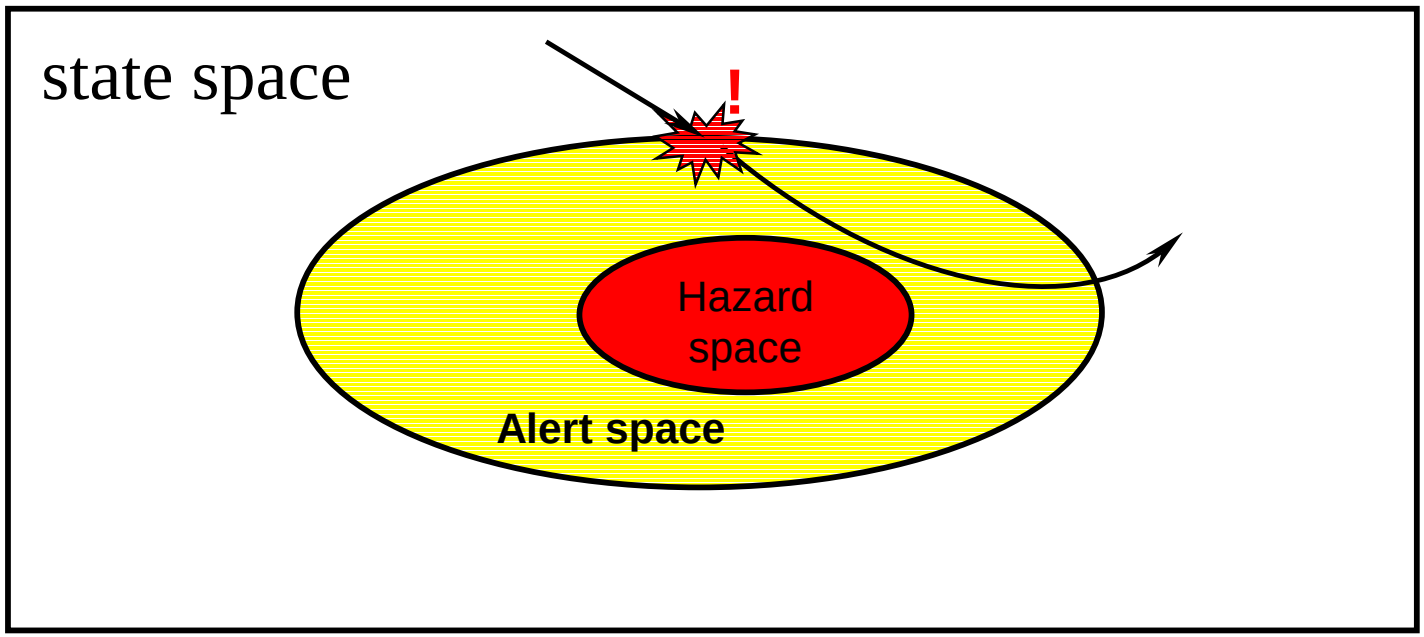


- **Already has occurred with TCAS & air traffic controller**
  - Several near misses
- **Potential for automation/automation dissonance is growing**
- **Also applies to other decision aids**

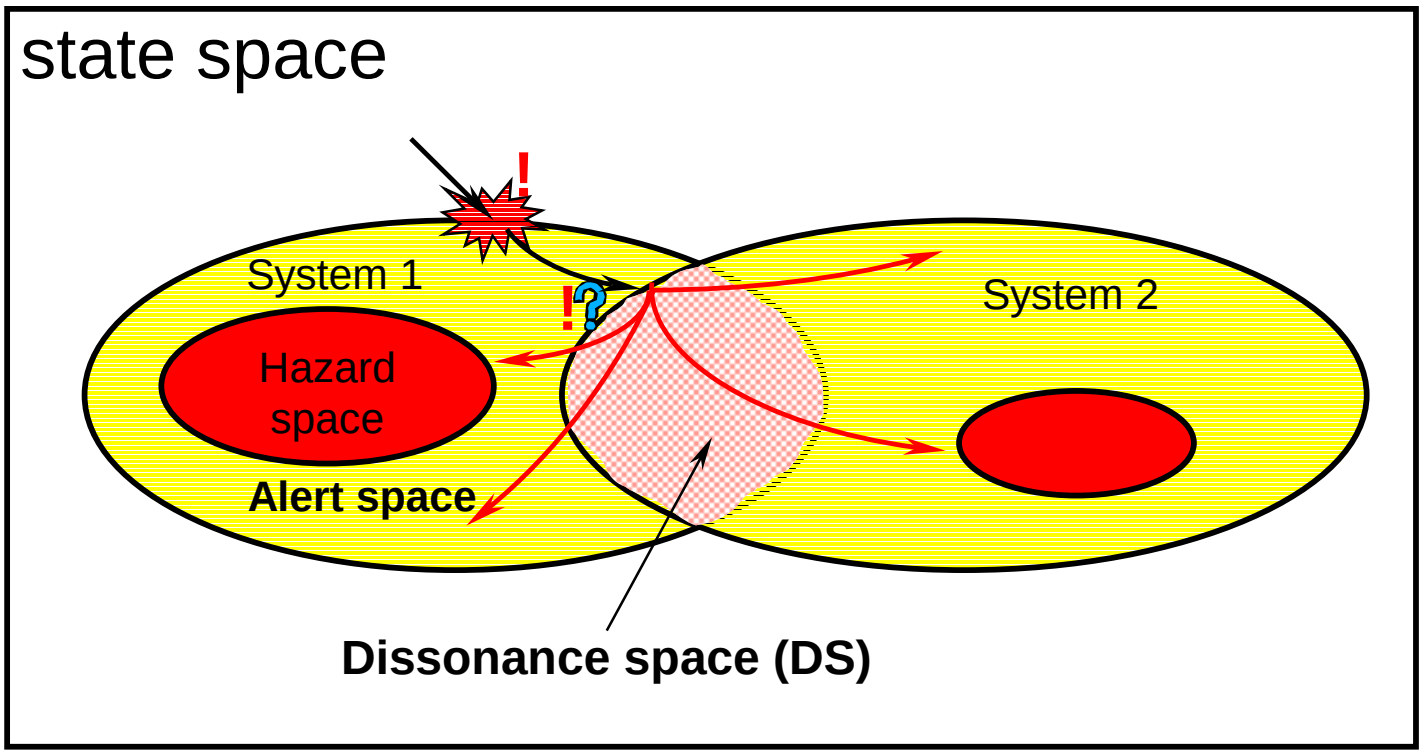
How Dissonance Affects the Process

- **Exposed to dissonance, human operator may**
  - ☐ Increase delay in taking action
  - ☐ Fail to take any action at all
  - ☐ Implement action contrary to automation command
- **Lead to an accident**
- **Lead to inefficient operation (unnecessary action)**
- **In the long term, distrust the system**

State Space Model of an Alerting System

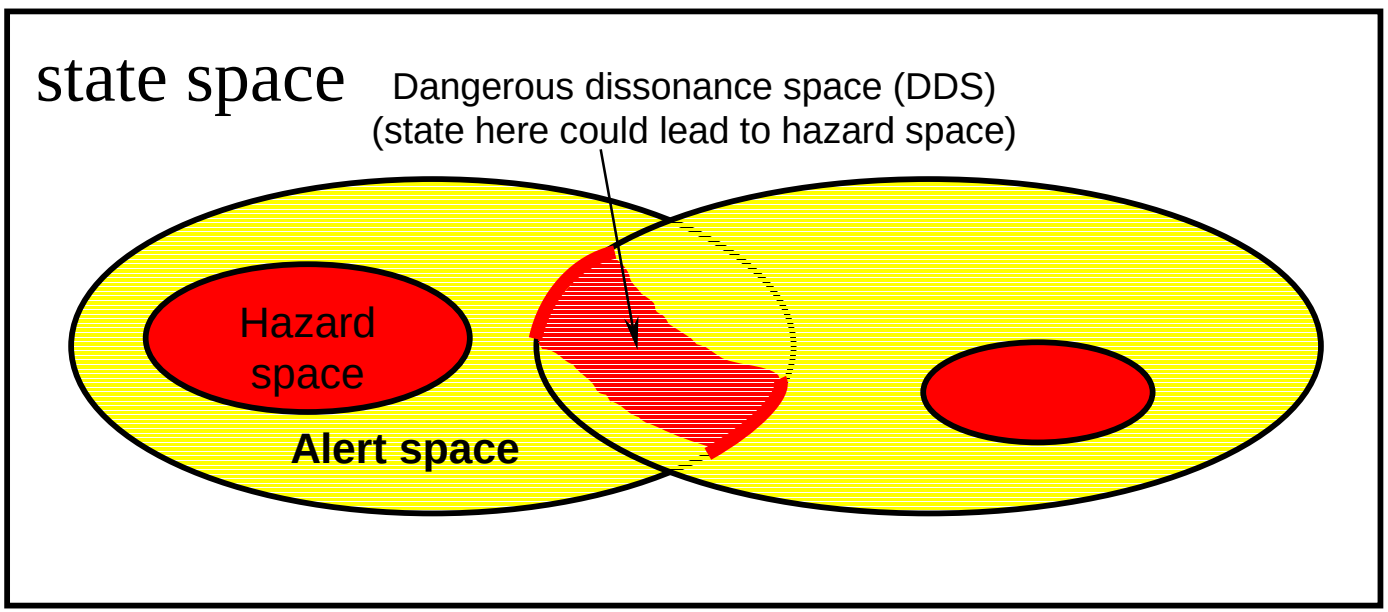


Dissonance Space

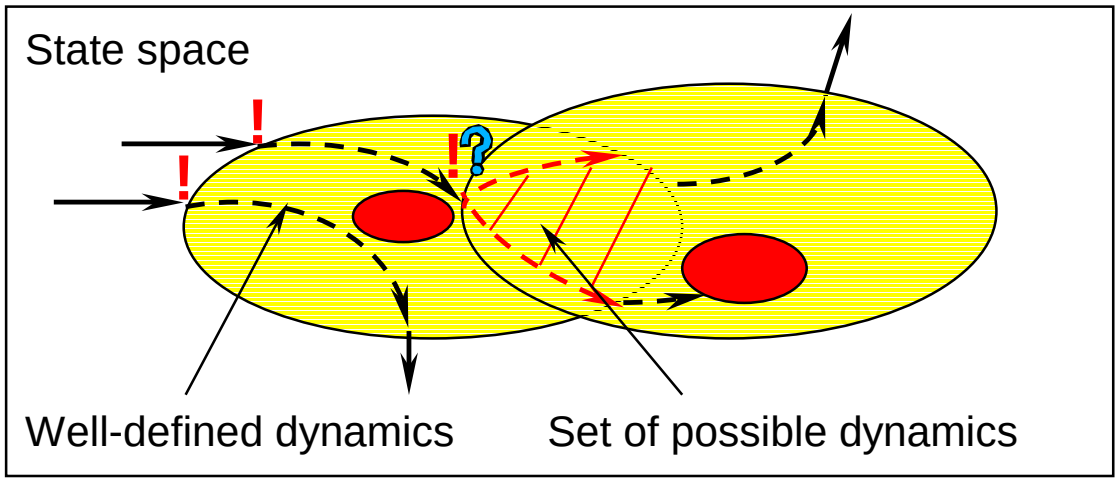


Dangerous Dissonance Space

- **Identify dangerous dissonance space in which human operator's response could lead the process to hazard space**
- **Modify system design to avoid unsafe consequences of dissonance**

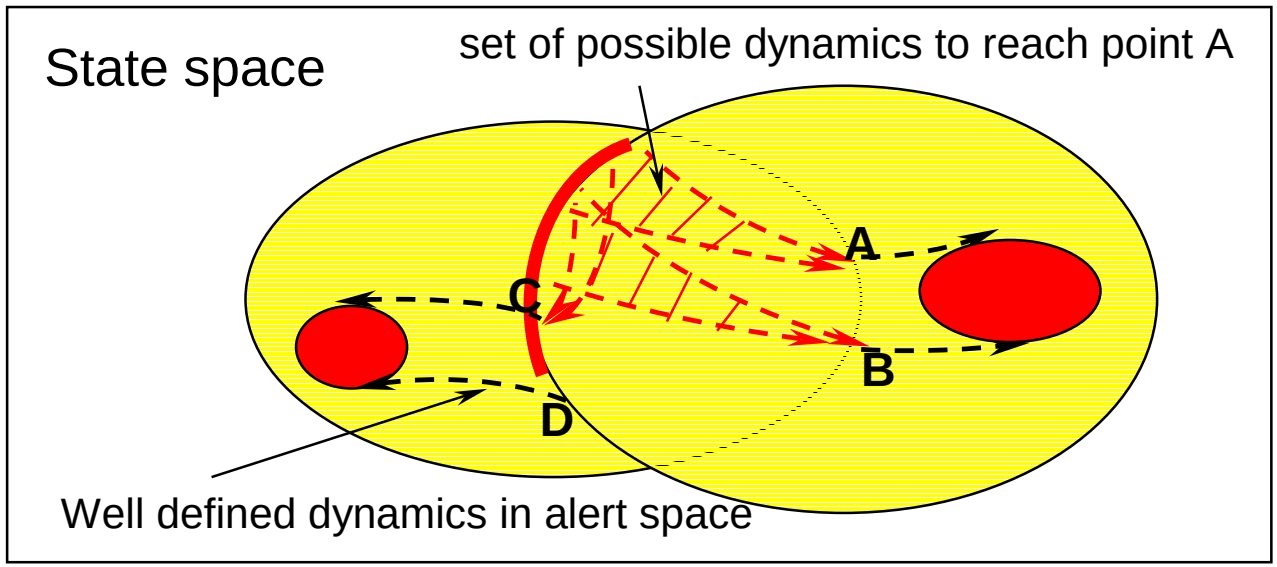


Hybrid Model With Transition Function



- **Transition function activated when continuous state hits boundaries (alerting thresholds)**
- **Transition function may be well-defined for individual system alert**
- **In dissonance space, transition function is even more uncertain**

Avoid Dangerous Effect of Dissonance



- **Hybrid system reachability analysis to identify DDS**
  - ☐Modify alerting system threshold function to eliminate DDS
  - ☐Modify alerting system command to reduce likelihood of entering DDS
  - ☐Train operator to reduce likelihood of hitting hazard space once in DS

Future Research

- **Identify dissonance that induces unnecessary, inefficient operation**
- **Apply the analysis to air traffic control systems**
  - ☐ TCAS and strategic conflict probes
  - ☐ Automation functions within the center TRACON automation system (CTAS)
  - ☐ CTAS vs. Other ground-based decision support systems
  - ☐ CTAS vs. Airborne decision support systems
- **Examining human factors effects of dissonance**